WESTCARB Regional Partnership

WESTCARB Region Update

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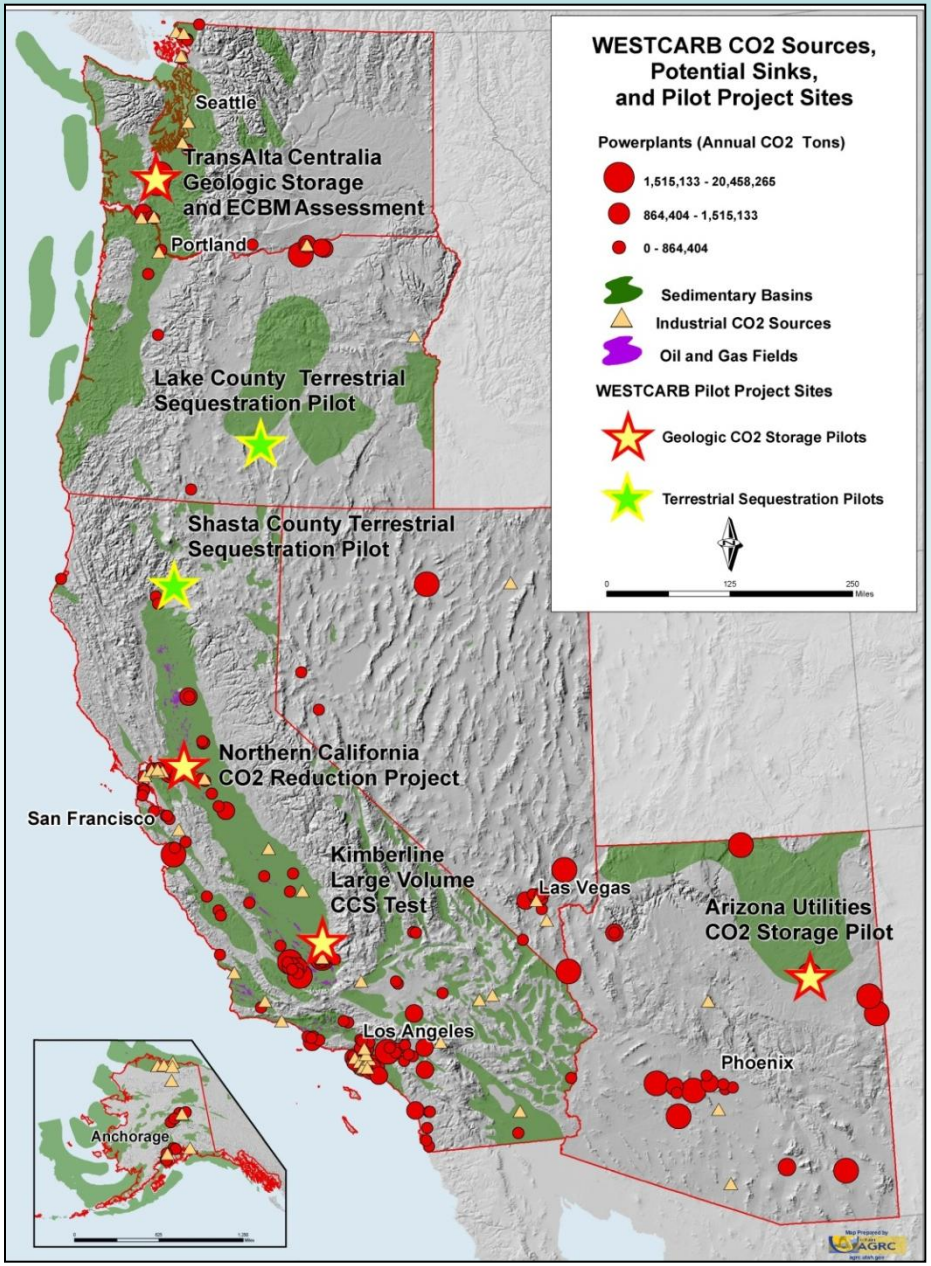
Overview

- Developments in WESTCARB region
  - CCS Projects
  - Policy
- “Deconstructionism” for lessons learned
- Defining the Path Forward—RTIP
- Conclusions

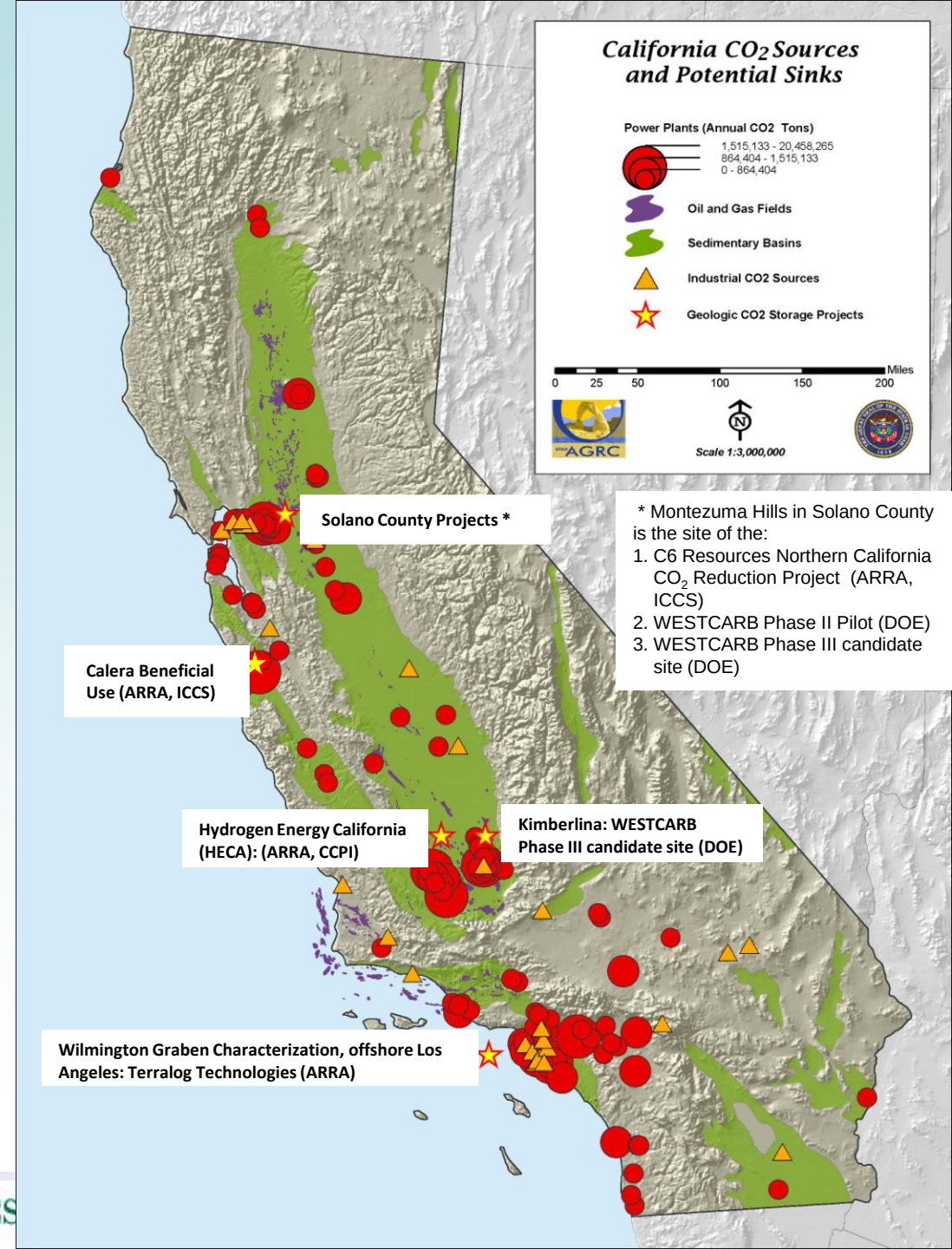
WESTCARB field projects

- Terrestrial field pilots in California and Oregon
  - Afforestation
  - Forest conservation
  - Fuels/fire management
- Four geologic site characterization pilots
  - ECBM/saline in Centralia, WA
  - EOR/saline in Kern County, CA (Kimberlina site)
  - Saline in Solano County, CA
  - Saline in Arizona's Colorado Plateau



Other California Projects

- HECA (ARRA-CCPI)
- C6 Resources (ARRA-ICCS)
- Calera beneficial use (ARRA-ICCS)
- Terralog-Wilmington Basin (ARRA)

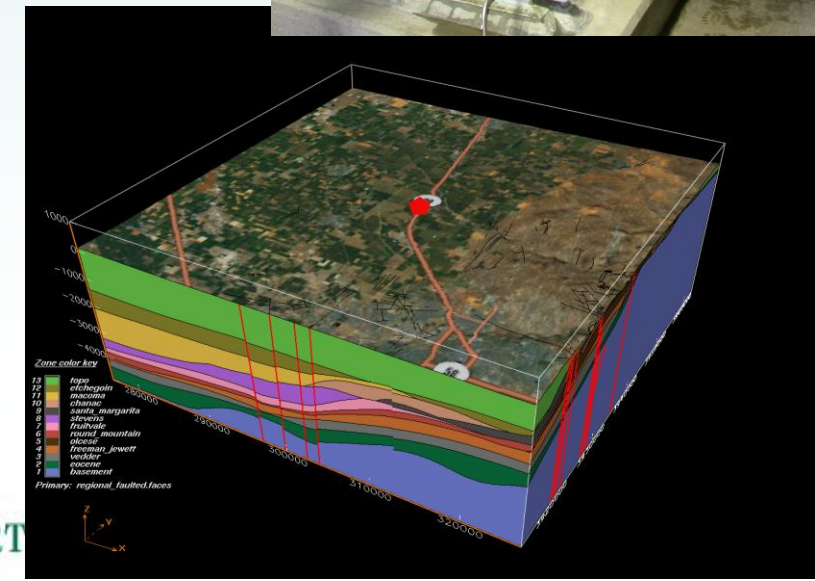


Hydrogen Energy California (HECA) plans to build a solid-fuel power plant with CO_2 capture and beneficial use for EOR

- Petcoke and coal gasification will provide hydrogen for 250 MW of electric power generation
- About 2 million tons of CO_2/yr will be captured and piped to Occidental's Elk Hills Field for EOR
- Planned operation by 2015
- ARRA-CCPI funding

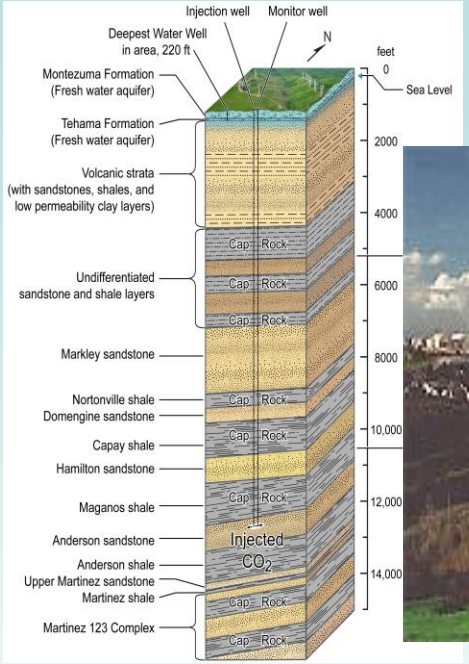
Kimberlina

- Clean Energy Systems (CES) plans expansion from existing 5 megawatt (MWe) pilot ZEPP plant to 170 megawatts thermal (MWth)
- ZEPP power plant will use oxy-combustion technology (and initially fire natural gas) and produce a relatively pure stream of CO_2
- Plant would emit 227,000 metric tons of CO_2 per year.
- Injection would take place in the Vedder sandstone, a saline formation at a depth of about 7,000 feet



Solano County

- **Concept is to capture and transport by pipeline approximately one million tons per year of CO_2 streams from industrial facilities located in the Bay Area**
- **Injection target is more than two miles underground in a saline formation**
- **Project designed to enable refinery compliance with AB32 and future caps**



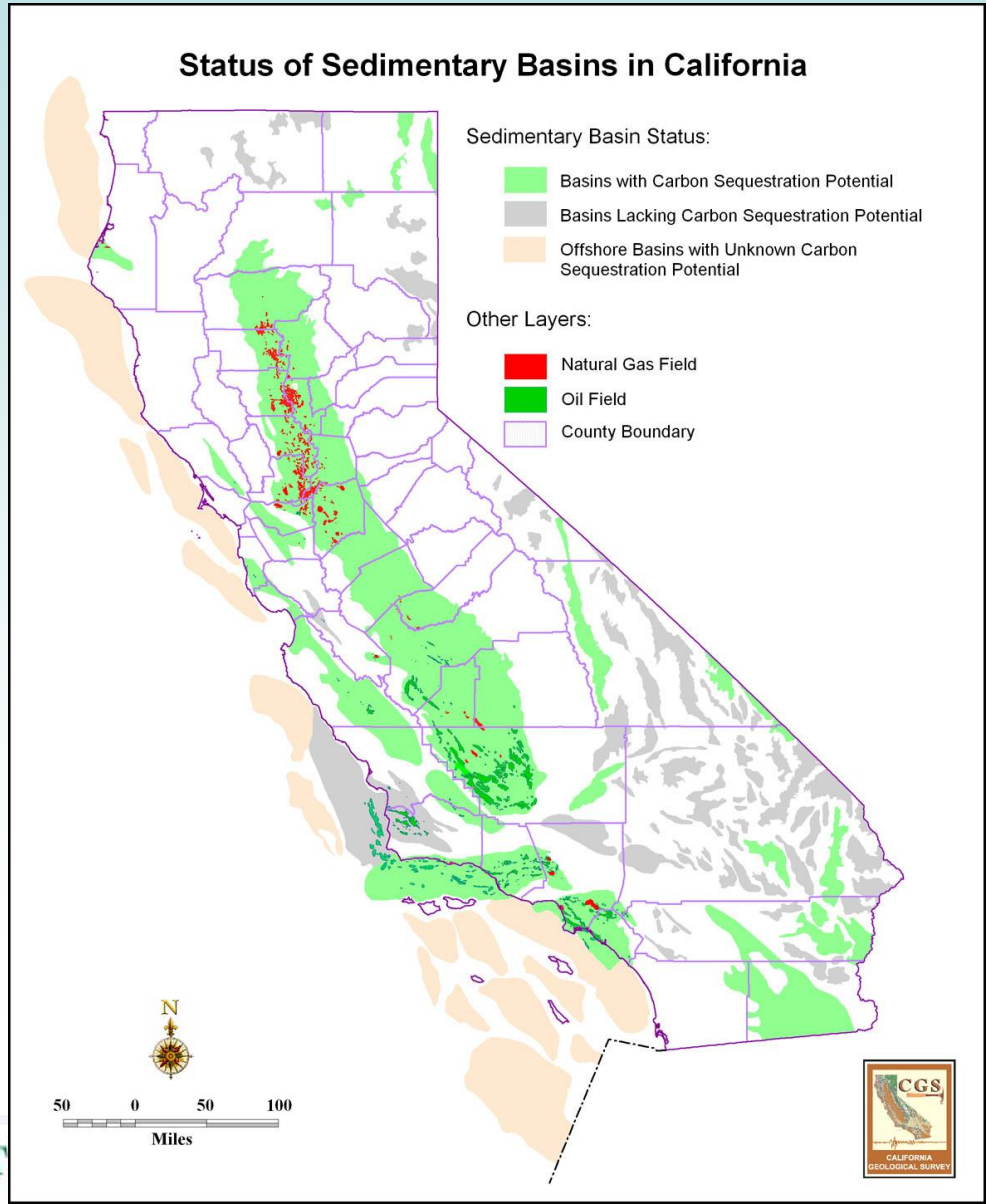
Aerial view of the Montezuma Hills

Calera Beneficial Use Project (ARRA, ICCS)

- Patented process converts captured CO_2 to green building products
- Pilot 5 ton/day with plans to scale-up to 1000 ton/day demo

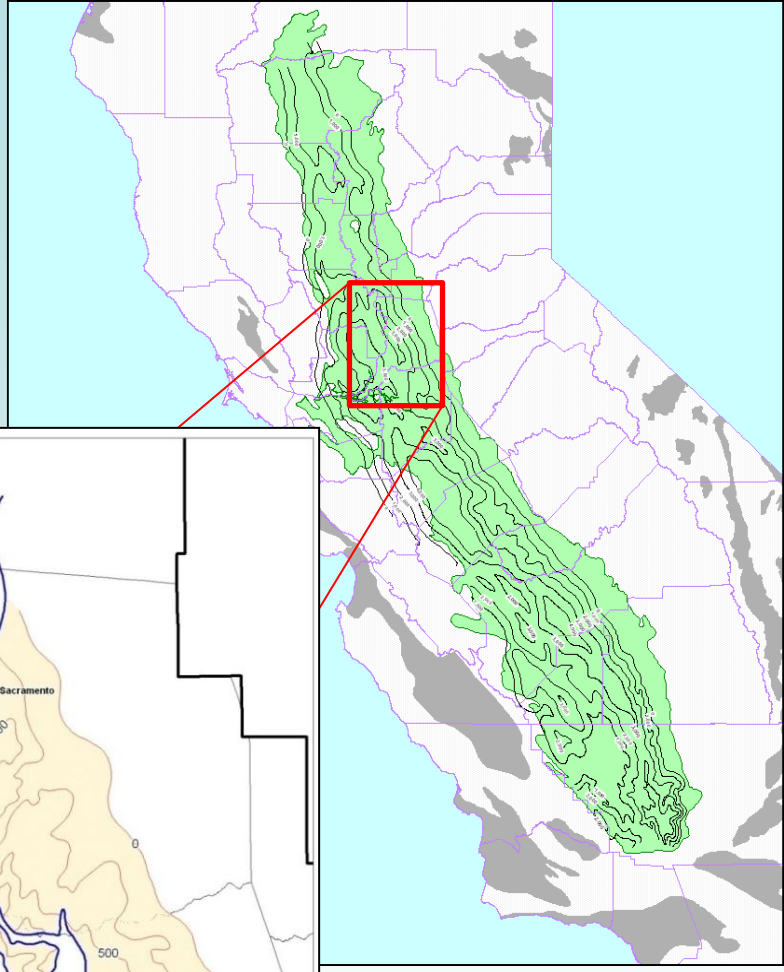
Geological characterization, focused on offshore resources

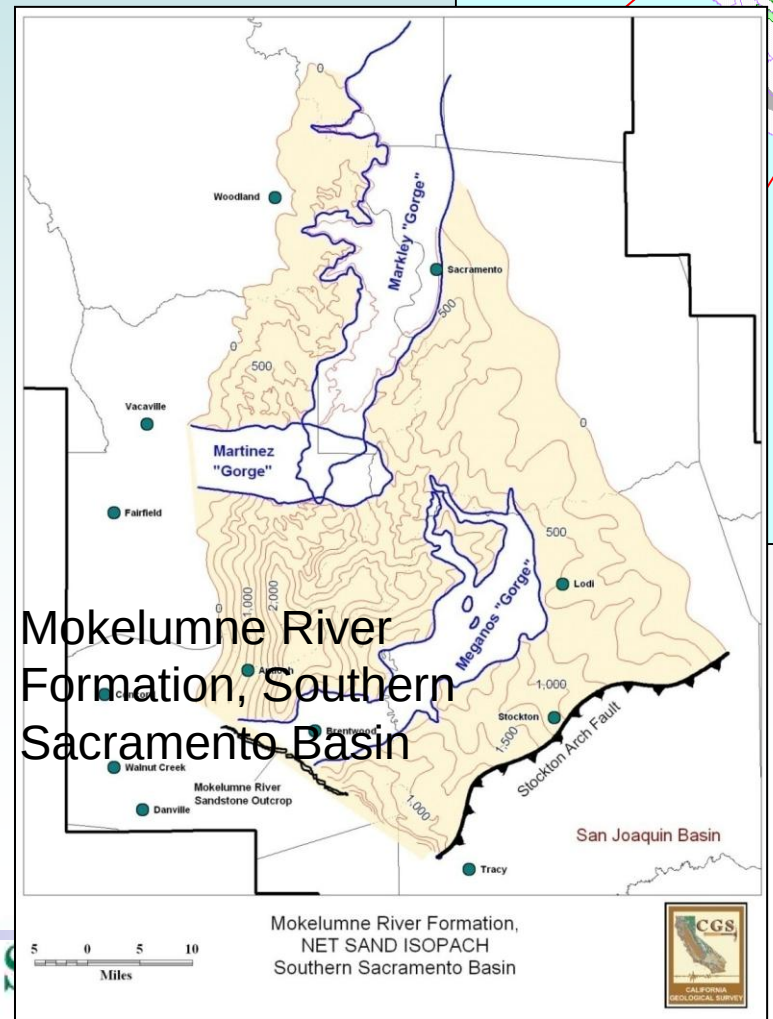
- CA Geological Survey completed survey of offshore basins
- Terralog Technologies received ARRA funding to characterize Pliocene and Miocene Formations in the Wilmington Graben, Offshore Los Angeles,
- The Los Angeles Basin presents a very unique and special combination of high need and significant opportunity for large scale geologic storage of CO_2.



WESTCARB undertaking more detailed characterization of key storage formations

- Isopach maps of target sand units
- Identification of compartmentalization
- Salinity
- Thickness of overlying seals

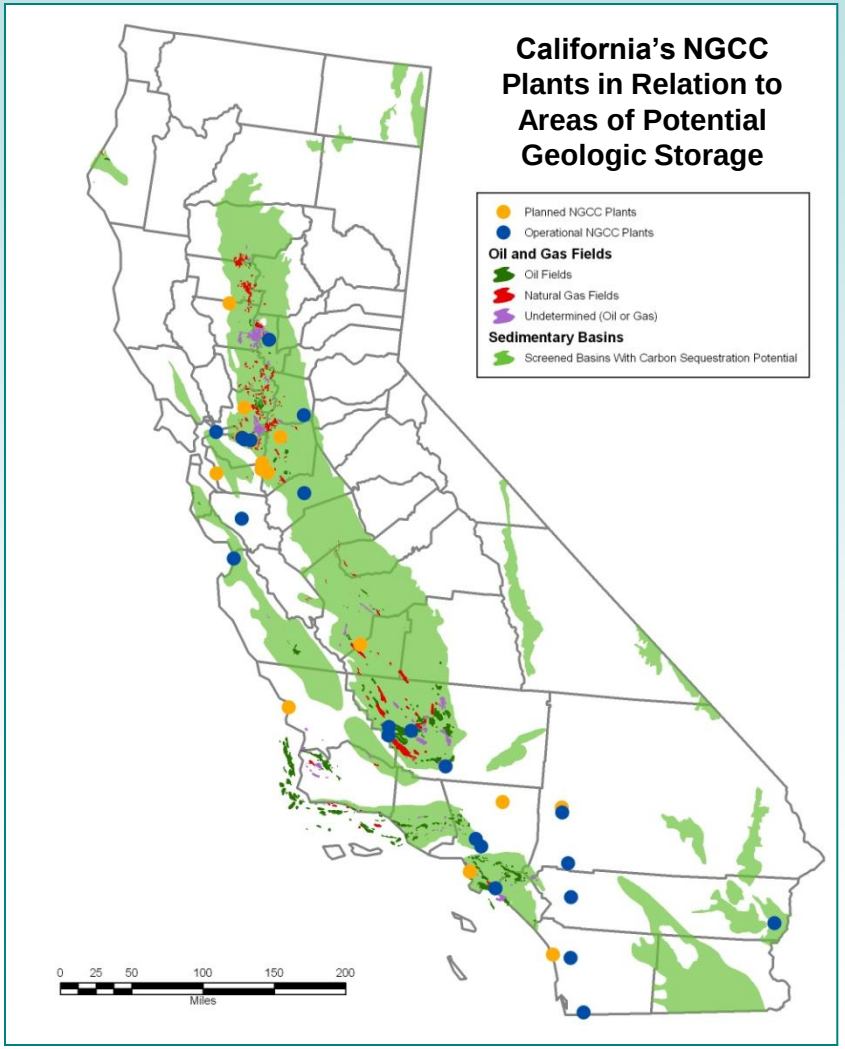




Mokelumne River Formation, Southern Sacramento Basin

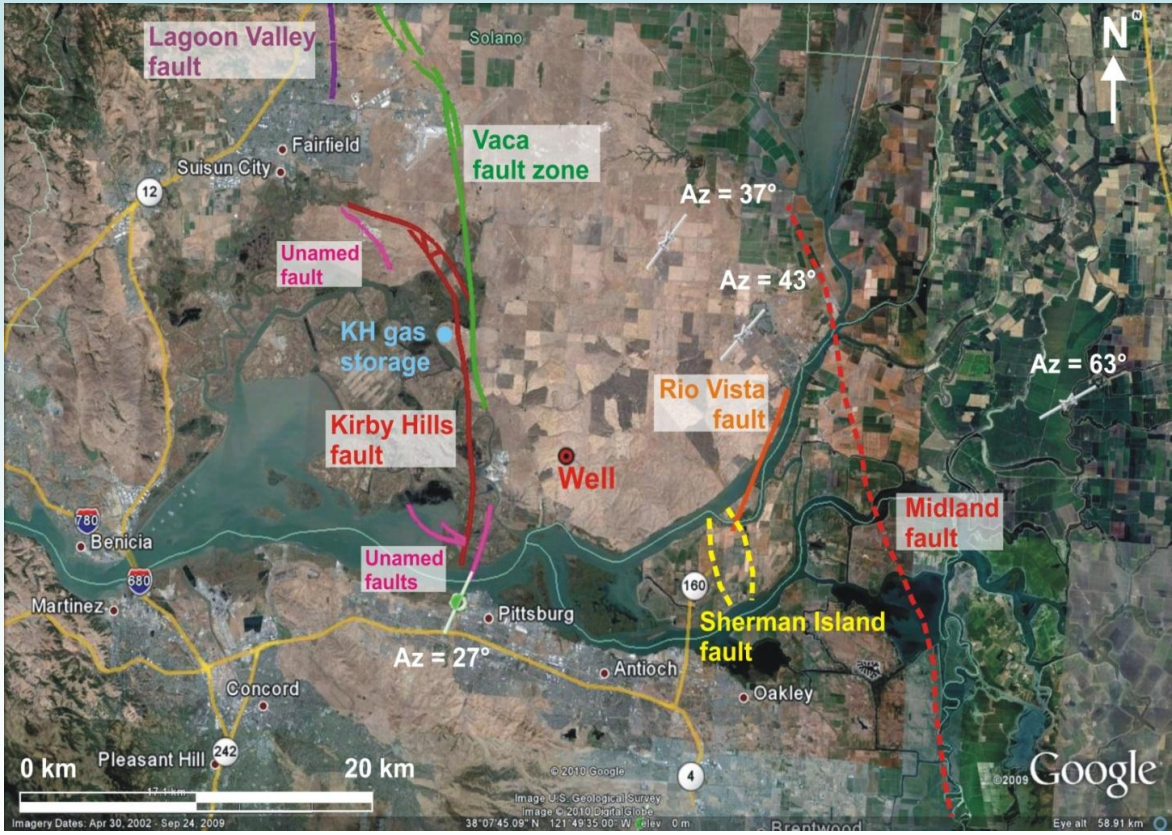
NGCC-CCS retrofit study for California

- Approximately 50 F-Class (and a couple of H-Class) gas turbines have been commissioned in California since 1998
- Which units could be considered candidates for future CCS retrofit?
  - Supportive site characteristics for CO_2 capture
  - Dispatch mode and remaining life
  - Proximity to storage or transport
  - Storage site options
- Working with PG&E, who is developing a GHG compliance strategy
- Output includes plans for a pilot



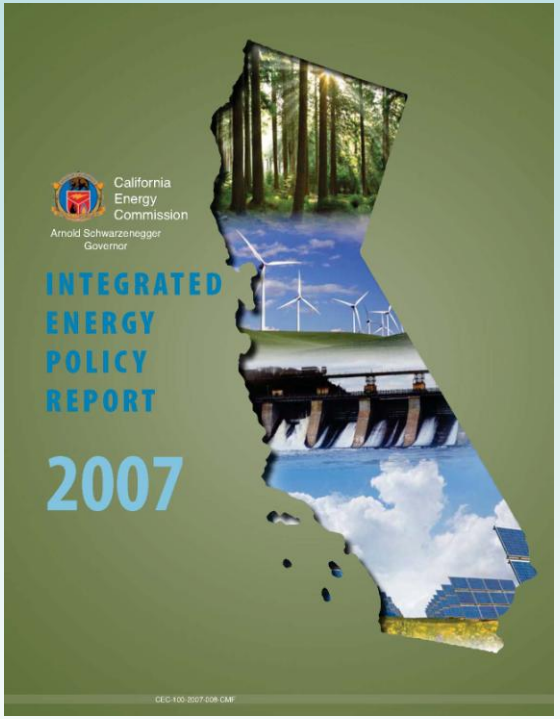
Seismic issues are an important consideration throughout most of the WESTCARB region

- California Geological Survey recently issued Seismic Hazard Map classifying faults according to age of activity
- LBNL and LLNL addressed seismic hazard issues for Solano County for proposed CCS project
- LBNL/WESTCARB established baseline seismic network for Solano County site
- WESTCARB working group to examine public perception and protocols



WESTCARB research also helping to inform policymaking for CCS

- California -- Integrated Energy Policy Reports; Assembly Bill 1925 report, CA CCS Review Panel
- Oregon – House bill 3543 GHG emissions reductions (forest sequestration)
- Washington – Senate bill 6001 GHG emissions reductions
- Nevada – Senate bill 422 GHG emissions reporting



California Carbon Capture and Storage Review Panel

- Formed in 2010 by the Energy Commission, California Public Utilities Commission, and the Air Resources Board
- Other state agencies involved include the California Department of Conservation and the California State Water Resources Control Board
- Panel is to review CCS policy and develop recommendations that could help guide legislation and regulations in California
- WESTCARB researchers are serving on the Technical Advisory Committee
- Four or five public meetings of the Panel are being held – next meeting is October 21 in Sacramento, CA
- Final report by the Panel is due at year-end 2010

Panel website:
http://www.climatechange.ca.gov/carbon_capture_review_panel/meetings/index.html

CCS in the context of California's climate change mitigation policy

- Governor's Executive Order, S-3-05, in 2005 established target GHG reduction levels:
  - 2000 GHG emissions levels by 2010
  - 1990 levels by 2020 *(~436 million metric tons)*
  - 80 % below 1990 levels by 2050 *(~90 million metric tons)*
- AB 1925 in 2006 asked for recommendations to accelerate geologic sequestration of industrial CO_2
- SB1368 specified a GHG performance standard for long-term electricity contracts, allows CCS
- Global Warming Solutions Act (AB 32) in 2006 put second goal into law **(Prop 23—suspends AB 32)**

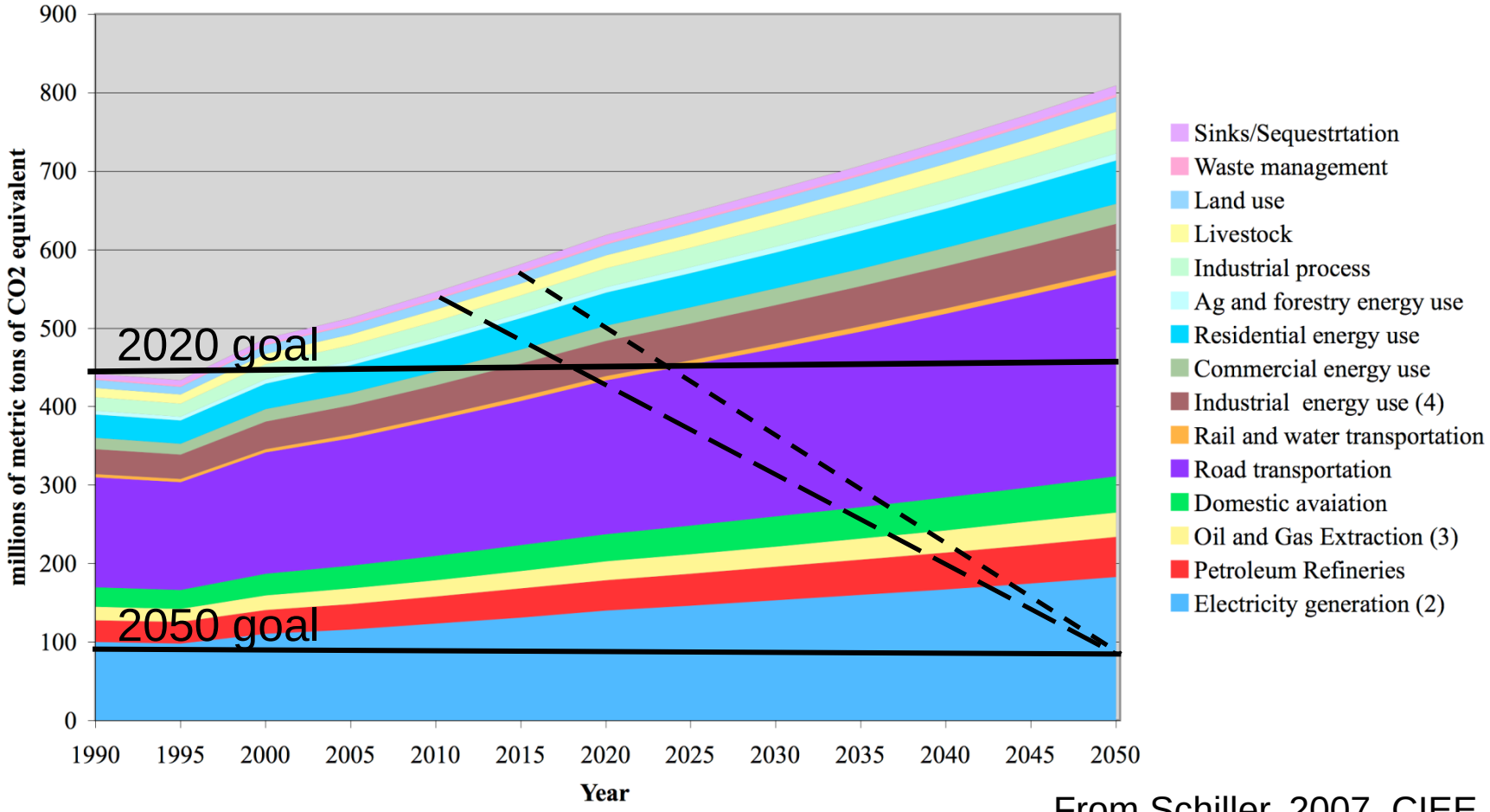
Reductions Needed to Meet 2050 Goal Require CCS

Values in million metric tons of CO_2 (eq)/yr

	Projected baseline in 2050 (avg. ann. growth 1990)	Reduction as percent of 2050 baseline	Reduction from 2050 to meet 20% of 1990 baseline
High Growth	**~990 (1.2%)**	**~900**	**~91%**
Moderate Growth	**~800 (1.0%)**	**~710**	**~89%**
Low Growth	**~630 (0.6%)**	**~540**	**~86%**

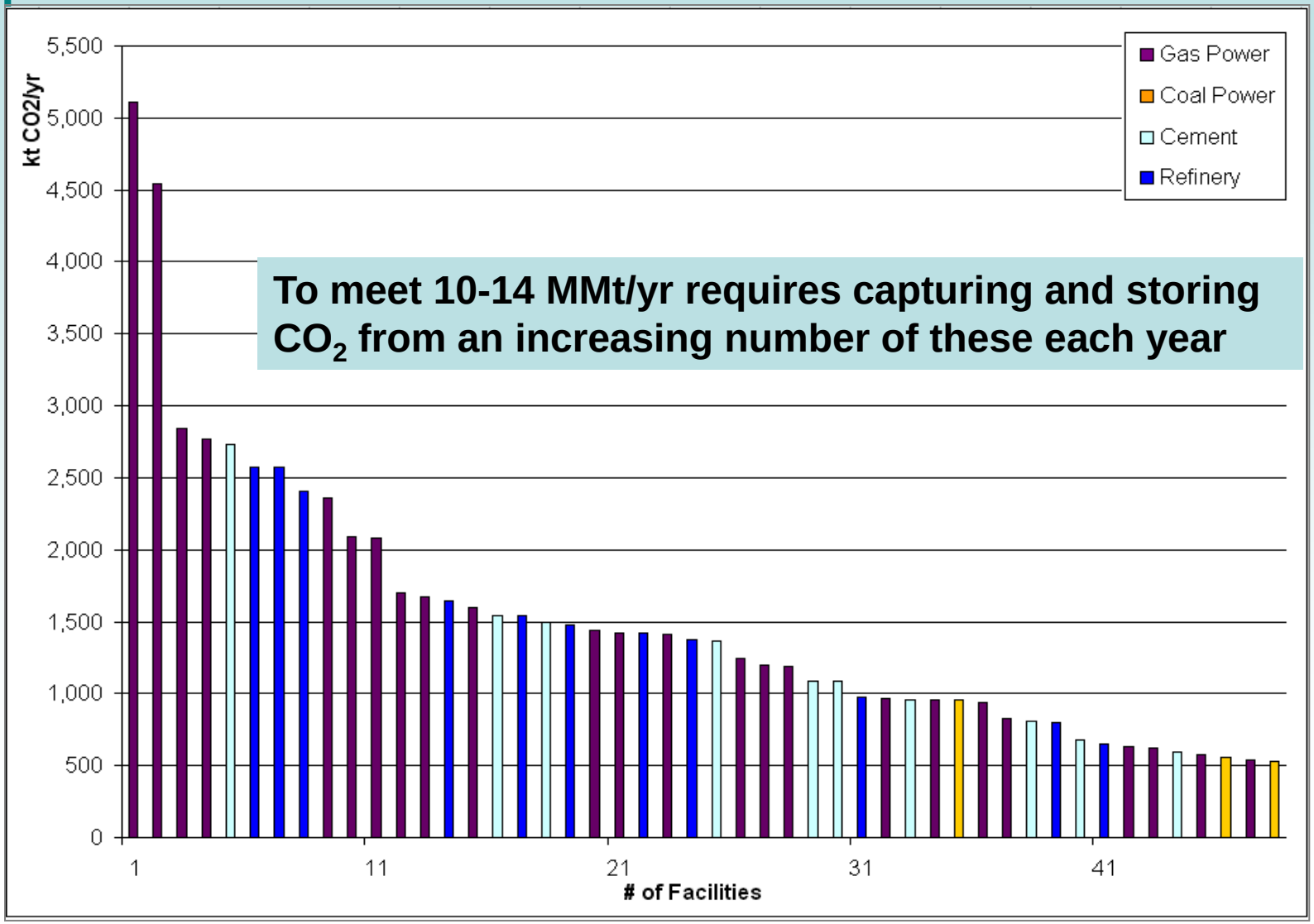
Will require a zero-carbon electricity sector

Assuming moderate future growth: ~10 MMT/yr now; 14 MMT/yr if no action before 2015

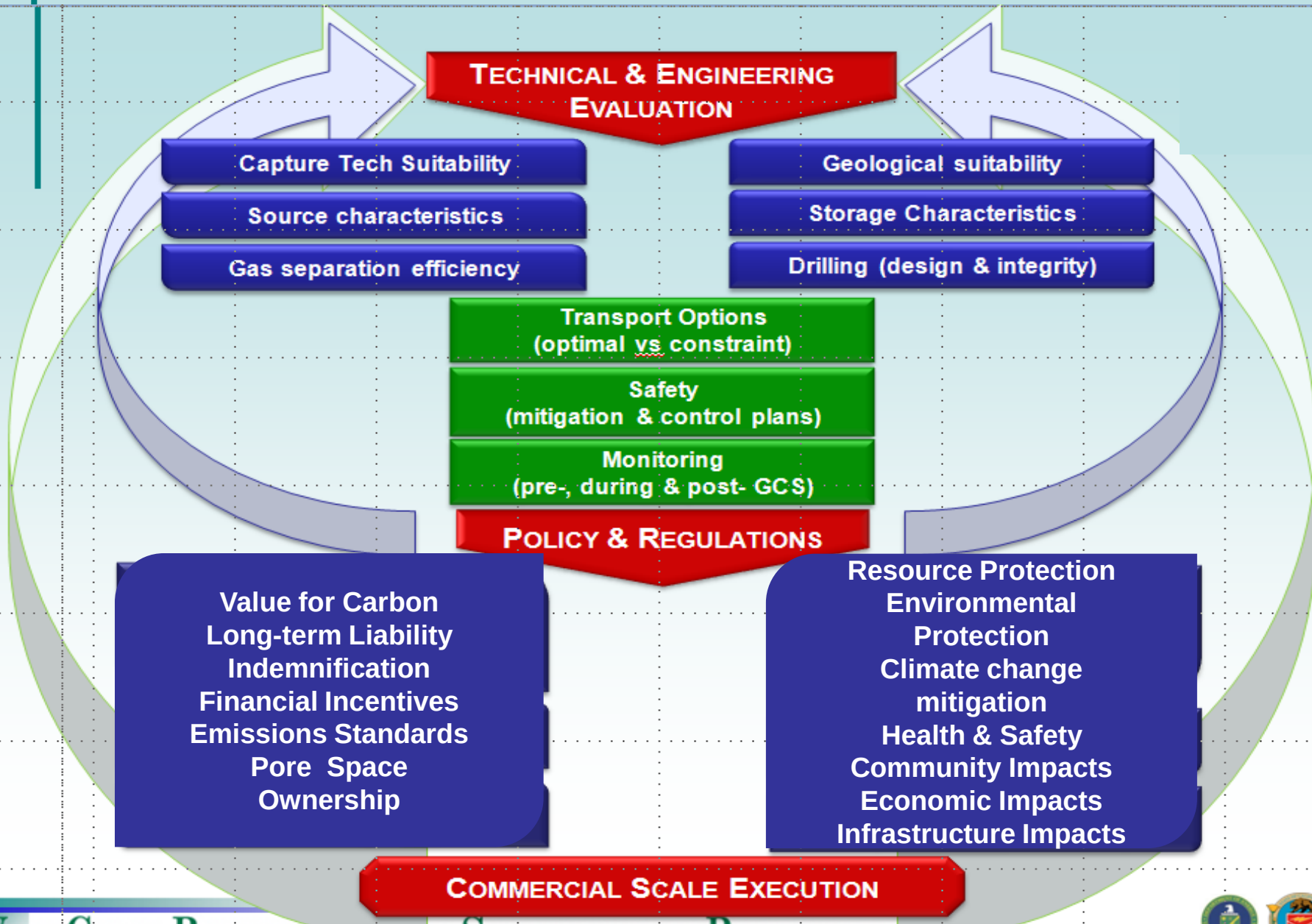


From Schiller, 2007, CIEE

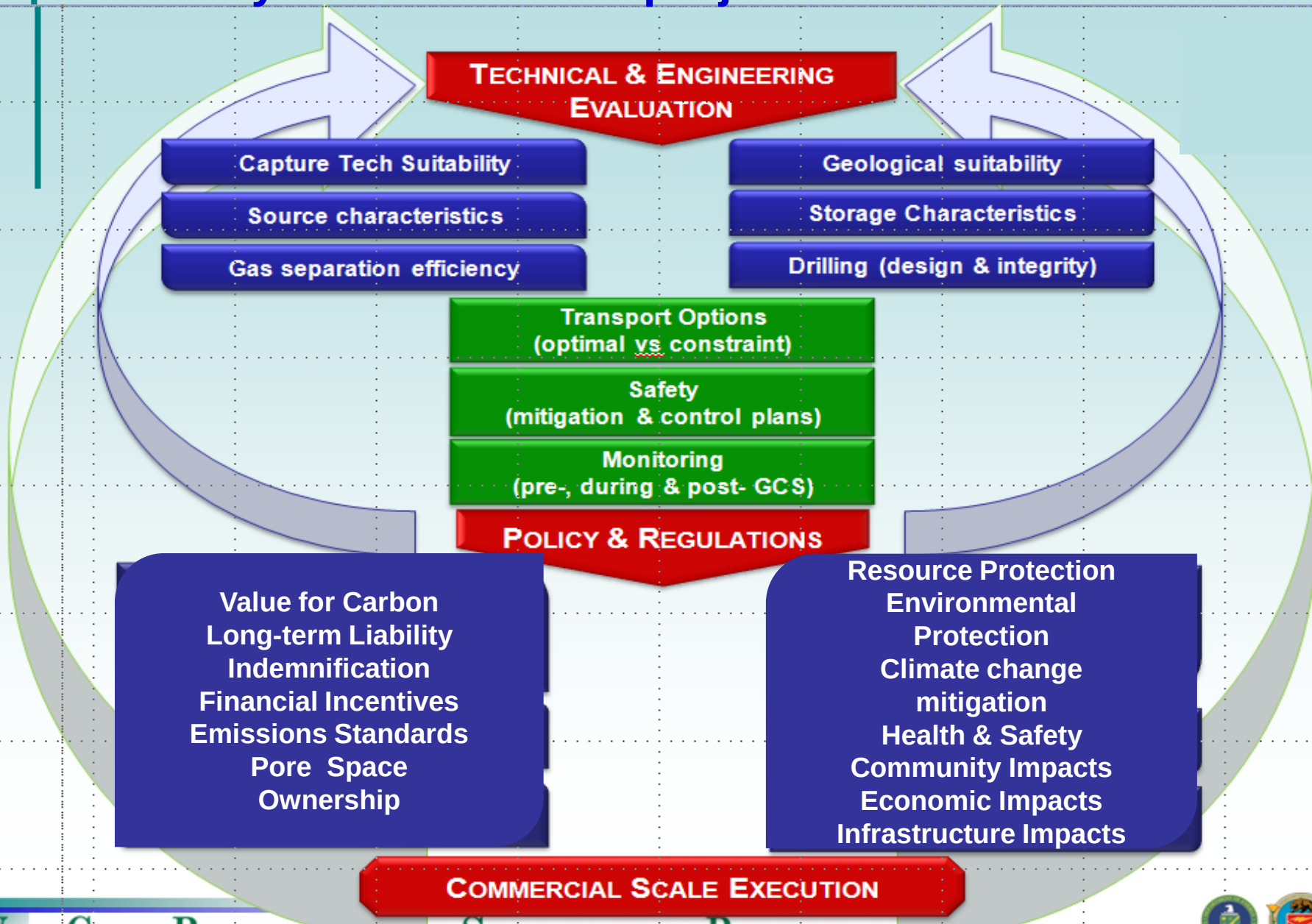
The largest CO_2 point sources in California are the best CCS candidates



Pathway to a successful project: components



Pathway to a successful project: RISKS



The box with components/risks that most frequently kill projects is the “Policy box”

- Value for Carbon
- Long-term Liability
- Indemnification
- Financial Incentives
- Emissions Standards
- Pore Space Ownership

Regional Technology Implementation Plan (RTIP)—Our approach seeks to link technical vision and policy out to 2050

- Input from stakeholders (2010 WESTCARB Annual Meeting) via breakout sessions
  - Capture and transportation
  - Geologic
  - Beneficial use
  - Terrestrial
- Integrate with state and regional energy and climate policy frameworks
  - Studies on infrastructure constraints
  - Carbon and energy flow
  - Regional policy initiatives (e.g., Western Climate Initiative, Western Governor's Association)

Conclusions

- **WESTCARB region states have ambitious GHG reduction goals and cap-and-trade under WCI**
- **There is no other way to reach 2050 goals except by using CCS without severe curtailment of energy usage and economic consequences**
- **Nevertheless, current policy tends not to recognize or facilitate CCS**
- **RCSP RTIPs can establish for policymakers**
  - **Viability of the technical path forward**
  - **Magnitude and rate of necessary CCS deployment**
  - **Policy instruments needed to enable widespread CCS adoption**